

## Chronology of Activities at Paducah Gaseous Diffusion Plant

Past activities (1952 to 1990) at PGDP are presented in chronological fashion within a series of functional areas summarizing key Plant operations and activities and relating to the safety and health of workers, the public, and the environment.

### 2.1 Site Background

In August 1950, the U.S. government determined that it would need to double the capacity of domestic fissionable materials production that existed at the Oak Ridge K-25 Plant. The Atomic Energy Commission (AEC) selected a Plant option consisting of 400 stages modeled after the K-31 facility at Oak Ridge (which would become C-331 at the Paducah Plant) and 480 stages twice the size of the Oak Ridge K-31 stages (which would become C-333 at the Paducah Plant). Based on a decision to disperse the major portions of the new production capacity, eight areas were identified as candidate locations for the Plant, all in the southeastern U.S. From the application of additional criteria, three sites were identified: the Kentucky Ordnance Works (KOW) at Paducah, the Louisiana Ordnance Plant at Shreveport, and the Longhorn Ordnance Works at Marshall, Texas. From these, the AEC approved, on October 18, 1950, the KOW site as the location for the new gaseous diffusion plant.

PGDP construction spanned 1951 through 1956 and was conducted in two phases. Construction of the first phase began January 2, 1951, and included erection of the following process and production facilities: C-331 and C-333, the gaseous diffusion process buildings; C-410/420, UF<sub>6</sub> Feed Plant; C-310, Purge and Product Withdrawal Building; C-315, Surge and Waste Building; and C-300, Central Control Building. On January 6, 1951, the Tennessee Valley Authority began construction of the four-unit Shawnee Steam Plant near the Paducah Plant on the Ohio River to provide a portion of the needed electricity. On February 15, 1951, Electric Energy, Incorporated began construction of the

Joppa Steam Plant, in Joppa, Illinois, to also provide electricity to PGDP. Authorization to proceed with the second phase of Plant construction was received on July 15, 1952. Two additional enrichment facilities, C-335 and C-337, were added, and construction was completed in 1956. Carbide and Chemicals Company (which became Union Carbide Corporation Nuclear Division) was named as the original site contractor based on the company's experience with gaseous diffusion operations at Oak Ridge. Carbide operated PGDP for the AEC, and its successor agencies the Energy Research and Development Administration (ERDA) and DOE, until 1984, when they were replaced through a competitive procurement by Martin Marietta Energy Systems, Inc.



Construction at PGDP

In the early 1950s, the Plant provided some of the better paying jobs in the area, if not the region. Workers believed that the mission of the Plant was important to national security, and they worked hard to meet expectations. Accordingly, being an employee of the Plant engendered respect and there was civic pride in the fact that Paducah was the location of a facility that played a role that was important to the nation. Many of the Plant's original operators and workers were military veterans and viewed the opportunity to work at PGDP as a way to continue their service to the country. This notion of service is reflected in the fact that a significant proportion of workers would

become long-term Plant employees, transcending changes in Federal oversight organizations and transitions in contractors.

Demands on the Plant and the workers were high, given the requirements of the Cold War. Work was difficult, production schedules were challenging, and the work environment was often hot, loud, dirty, and laden with noxious fumes. The security demands of the Cold War also affected worker awareness of hazards in that, prior to 1989, documents discussing many aspects of operations were classified and, at the direction of line management and AEC security, detailed knowledge of work activities was based on a “strict need to know.” The workers’ sense of loyalty and service would also translate into acceptance of these security policies and the expectation that they would be told everything that they needed to know.

From the 1950s to the 1990s, government oversight of ES&H elements of PGDP contractor activities evolved. The primary offices of the Federal regulatory organizations for the diffusion plants — the AEC, ERDA, and DOE — have always been located in Oak Ridge, although there was a Federal presence at PGDP for most of the period 1952 to 1990. Records indicate AEC involvement in collaborative research activities related to radiation and health physics in the 1950s through the 1970s, but there is little evidence of direct observation of, or direction to, the PGDP contractor regarding ES&H, which was not an uncommon practice for a regulatory agency during that period. Carbide provided quarterly progress reports to the AEC summarizing operational, maintenance, construction, industrial hygiene, health physics, and accident data and analysis and responded to information requests on health physics issues. However, the interactions between the contractor and AEC clearly emphasized maintaining or increasing production. In the 1970s, as new environmental regulations were enacted, there is evidence of growing involvement by the Commonwealth of Kentucky and OR in site activities and in the effects of site activities on the environment and the public. In the 1980s, increased DOE oversight was evidenced by additional ES&H inspections by the local site office and OR. On September 18, 1985, then-Secretary of Energy John Herrington announced that DOE-wide environmental surveys would be conducted; the PGDP survey occurred in November and December 1987. These surveys led to changes in DOE and contractor ES&H programs. However, the 1990 DOE Tiger Team identified ineffective DOE oversight and unclear oversight roles and responsibilities as key management findings.

## 2.2 Operations

Although major construction activities would continue through 1956, Union Carbide began hiring approximately 1,700 permanent Plant workers in 1951. The first process buildings, C-331, C-333, C-310, and C-315, were completed and started operation in September 1952, and the first product was withdrawn in November. The purpose of the gaseous diffusion plant has been and continues to be the enrichment of uranium, initially for military applications and subsequently for commercial reactor fuel. PGDP enriches feed material in the form of  $UF_6$  gas with approximately 0.7 percent uranium-235 to  $UF_6$  with one to three percent uranium-235. The enriched product from PGDP was sent to other DOE sites at Portsmouth or Oak Ridge for further enrichment. Most  $UF_6$  feed material came from the depleted tails produced during normal diffusion operations at PGDP and from Oak Ridge and Portsmouth. From 1952 through 1977,  $UF_6$  feed material was also produced from uranium trioxide or  $UO_3$  (called “yellowcake”) at PGDP in Buildings C-410 and C-420; this feed material was supplied by sources such as El Dorado Mining and Refining, Mallinckrodt Chemical Works, and General Chemicals (now Allied Chemical) and comprised less than 10 percent of the  $UF_6$  fed to the cascade. From 1953 through 1964 and intermittently from 1968 through 1977, the feed plant also produced  $UF_6$  from  $UO_3$  from spent reactor fuel processed at the Hanford and Savannah River sites. After 1977, all feed came in the form of  $UF_6$  from outside sources such as Oak Ridge, Portsmouth, and Allied Chemical.

Although natural uranium is not a highly radioactive material, it is toxic, both chemically and radiologically, when inside the body. The uranium exposure pathway of greatest hazard at PGDP was inhalation of uranium dust. Feed material was made from production reactor tails from 1953 until 1964, and intermittently from 1968 to 1977. The percentage of PGDP cascade feed material from reactor tails averaged 19 percent during the 19 years this material was used, ranging from 3 percent in 1975 to 65 percent in 1973. Processing of  $UO_3$  into  $UF_6$  was accomplished in three steps: reduction, hydro-fluorination, and fluorination (see Figure 3).

Reduction involved transforming  $UO_3$  into  $UO_2$  (commonly referred to as “black oxide”) using hydrogen gas. Hydro-fluorination of  $UO_2$  into  $UF_4$  (commonly referred to as “green salt”) was accomplished by adding anhydrous hydrofluoric acid (HF). Fluorination was